Chapter 26
Virtual Reality and Point-Based Rendering in Architecture and Heritage

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ABSTRACT

Recent advances in acquisition technologies such as LiDAR, range cameras and photogrammetry have put point clouds once again in the forefront of several fields with applications in Computer Graphics, Vision and Machine Learning, such as civil engineering, architecture, heritage and archaeology. Taking also into account new progressions in Virtual Reality that are also making VR relevant again, the possibilities when using these two technologies together are endless. From the improvement of architectural workflows, to the conservation of important ancient monuments, these two technologies can improve current efforts substantially. This chapter focuses on how these two fields can be combined in new and innovative ways, so that professionals can optimally exploit the advantages that these improved technologies can offer.

INTRODUCTION

Nowadays, acquisition technologies such as LIDAR (Laser Imaging Detection and Ranging) allow us to obtain high-precision georeferenced 3D scans of the real world in an easy and fast way. These types of datasets are called point clouds. These scanners not only provide position information but also color data associated to a point, yielding not only precise but also realistic looking 3D models by applying

DOI: 10.4018/978-1-5225-5469-1.ch026

advanced point-based rendering algorithms. In disciplines like heritage, architecture or most engineering's, being able to have a detailed virtual representation of physical objects or places, in which you can measure or perform virtual walks, can be really important. Engineers can track and visualize from the desk the state and performance of the works, in addition to applying all kinds of computations easily and accurately. Archaeologists can store and manage exact digital copies of the pieces they are working with and make restoration plans; architects can represent the state of buildings and all the technical data too; urban planners can work on digital models of entire cities; and a long etc. This means a clear advantage over classic workflows, in which it would be necessary to go back to the field to examine a new area or perform certain measurements; this drawback is eliminated when you have a high precision 3D model of the site at your disposal.

Usually, the amount of data that results from the scanning of a big site with millimeter precision was not manageable by commodity hardware at once, and datasets would have to be decimated if an efficient out-of-core software solution is not available. Recent advancements in Computer Graphics and High Performance Computing (Gobbetti & Marton, 2004; Allard, Lesage, & Raffin, 2010; Jaspe, Mures, Padrón, & Rabuñal, 2014) have resulted in transparent out-of-core solutions that allow the user to visualize these datasets in real-time and perform measurements or other computations on them. Therefore, making it easy to spawn an algorithm that runs on the arbitrarily huge point cloud dataset, such as, for example, any kind of pre- or post-processing. Whilst these approaches on their own already present a big advantage and reduce the amount of work hours needed to perform certain tasks when obtaining and processing digital models for heritage or architecture, they can be dramatically improved by applying new workflows that take advantage of the possibilities of the most recent virtual reality technologies on commodity hardware, resulting in a higher level of immersion, interaction and realism when dealing with huge, highly detailed datasets.

Virtual Reality has been a hot research topic since the appearance of computer graphics, but lately there have been huge advances in the form of high quality and affordable commodity hardware, for example with headsets such as the Oculus Rift. The Rift is an upcoming head-mounted virtual reality display, which will soon be available for the mainstream, along with other similar new VR hardware: Sulon Cortex, CastAR, Altergaze, etc. These new devices also offer new possibilities in the field of Augmented Reality, up to now limited to tablets and smartphones as far as commodity hardware is concerned. In fact, Virtual Reality and Augmented Reality technologies have now achieved the point where it can effectively be applied in in conjunction with the aforementioned workflow will yield great advantages for architects, engineers and heritage professionals alike.

This article shows new possibilities of application for Virtual Reality and Augmented Reality with massive point clouds in real world architectural and heritage workflows.

BACKGROUND

Point-based rendering has been around for a while (Levoy & Whitted, 1985), but lately there has been a renaissance in point-based graphics. This is a consequence of the increment in acquisition hardware precision, and the decrement of its cost. Examples of point clouds used in heritage applications can be seen for example in (Boehler, Heinz, & Marbs, 2002). This work highlights the potential in the usage of laser scanners and point clouds to document cultural heritage sites. Furthermore, in (Yastikli, 2007) we can see another example in which the aforementioned technologies are proved to be extensively useful